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# Rehabilitation of Patients with Nontraumatic Spinal Cord Injury in the Netherlands: Etiology, Length of Stay, and Functional Outcome

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**Background:** Patients with nontraumatic spinal cord injury (NTSCI) are different from patients with traumatic spinal cord injury. A better understanding of the characteristics of NTSCI and their influence on length of stay (LOS) and functional outcome might help professionals in planning rehabilitation and predicting outcomes in NTSCI. **Objective:** To describe personal and injury characteristics, etiology, LOS, and functional outcome after inpatient rehabilitation in patients with NTSCI. **Methods:** Retrospective single-center study including 124 patients who were discharged between 2006 and 2010 from their initial inpatient rehabilitation after onset of NTSCI. Information about personal and injury characteristics, LOS, and functional outcome was collected from medical files. Descriptive statistics were performed, and associations between etiology, LOS, and functional outcome were investigated. **Results:** Fifty percent of participants were male, and mean age was 54.9 years (SD 13.7). Most lesions were classified as American Spinal Injury Association Impairment Scale (AIS) D (68.8%) and paraplegic (76.6%). The most frequent etiologies were degeneration (25.8%), vascular disease (21.8%), benign tumor (16.1%), and malignant tumor (15.3%). Discharge destination was usually a private residence (84.6%). Median LOS in inpatient rehabilitation was 61.0 days (interquartile range [IQR], 38.3-111.8). Median functional status score was 47.5 (IQR, 30-70) at admission and 90 (IQR, 75-100) at discharge. Etiology was a significant predictor of LOS and functional status at admission and discharge, but not of functional improvement during inpatient rehabilitation. **Conclusion:** Spinal degeneration, tumor, and vascular disease were the most common causes of NTSCI. All etiology groups improved during inpatient rehabilitation. **Key words:** etiology, length of stay, nontraumatic spinal cord injury, outcome, rehabilitation.

Spinal cord injury (SCI) is a severe condition with a worldwide incidence of 10.4 to 83 cases per million per year.<sup>1</sup> Patients are frequently left with a range of persisting disabilities that have a great impact on their lives and the health care system. Although previous literature reports a greater incidence of traumatic SCI (TSCI),<sup>2,3</sup> more recent literature suggests nontraumatic SCI (NTSCI) is more common.<sup>4-6</sup> Common causes of NTSCI are spinal degeneration, tumor compression, vascular disease, infection, and inflammation, with the first 3 being reported as the most frequent etiologies.<sup>2-4,7-11</sup> These causes are diseases of advancing age, which probably explains the positive correlation of the incidence of NTSCI and age<sup>2,5</sup> and suggests that the number of patients with NTSCI will grow in the years to come.

Older patients may have more co-existing health problems and lesser physical capacity, so

that functional outcome, length of stay (LOS), and rehabilitation needs of patients with NTSCI might be different from patients with TSCI.<sup>2,4,5</sup> For these reasons, many patients with NTSCI might need an adapted (ie, less intensive) rehabilitation program. Many specialized rehabilitation centers give less priority to the rehabilitation of this group, thereby possibly not giving them the best treatment available.<sup>12</sup> Several studies focused on NTSCI as a different entity from TSCI,<sup>3,5,6,8,9,11,13,14</sup> but most of these reports involved a relatively small number of patients and showed little attention to the different etiologies of NTSCI.<sup>9</sup> Other studies compared characteristics, LOS, or functional outcomes of patients with TSCI and patients with

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NTSCI, but, again, without making a distinction between the different etiologies of NTSCI.<sup>2,4,7,14,15</sup> It is to be expected that etiology makes a difference. For example, patients with SCI due to spinal column degeneration will on average be older and have more co-morbidity and therefore have a different rehabilitation outlook than patients with SCI of, for example, vascular origin. A better understanding of the characteristics of NTSCI and their influence on LOS and functional outcome might help professionals in planning rehabilitation and predicting outcome in NTSCI.

The aim of our study was to explore differences in demographic and injury characteristics, LOS, and functional outcome in patients with recent NTSCI according to etiology. Because of the lack of preliminary research, we do not have a basis for generating specific hypotheses.

## Materials and Methods

### Study design

A retrospective single-center cohort study was performed.

### Patients

Data were collected on patients with NTSCI who were discharged between 2006 and 2010 from their initial inpatient rehabilitation in De Hoogstraat in Utrecht, the Netherlands. Patients with Guillain Barré syndrome, poliomyelitis, spina bifida, Friedrich's ataxia, and conversion syndrome were excluded.

### Procedure

Data on demographic and injury characteristics were collected by the first author (J.J.V.) from admission and discharge letters written by the patient's rehabilitation physician. Data on functional status were collected with an existing registration form,<sup>4</sup> filled in by the patient's rehabilitation physician at admission and discharge. Under Dutch law, the use of data from medical files for research purposes is allowed without previous consent as long as the data are anonymous and the person who collects the data

is legally entitled access to the patients' files (eg, a team member). De Hoogstraat informs new patients about the possible use of their data for research and gives them the opportunity to decline this use. None of the patients declined.

### Instruments

Data on patient (birth date, sex) and SCI (level, completeness) characteristics were retrospectively assessed using a form developed in an international project.<sup>16</sup> Level and completeness of SCI were determined according the American Spinal Cord Injury Association (ASIA) standards.<sup>17</sup> Pattern of onset of NTSCI symptoms and the classification of etiology of NTSCI was based on the International Nontraumatic Spinal Cord Injury Data Set.<sup>18</sup> LOS in an acute care hospital and LOS in the rehabilitation hospital were defined as the period from the date of admission to the date of final discharge, ignoring interruptions. Functional status at admission and discharge was prospectively recorded with a scale consisting of 5 items (mobility, self-care, bladder management, bowel management, and transfers) scored on a 4-point scale: completely dependent, partially dependent, independent with use of an aid, or completely independent. The total score is between 0 (*completely dependent*) and 100 (*completely independent*).<sup>4</sup>

### Statistical analysis

Age at rehabilitation admission was calculated and dichotomized with the mean age as the cutoff point. LOS (in days) in rehabilitation was defined by the period between admission and discharge, thereby ignoring interruptions such as periods of re-admission to the acute hospital. Functional improvement during inpatient rehabilitation was calculated as the discharge score minus the admission score. Finally, functional improvement per day of inpatient rehabilitation was calculated.

Associations between NTSCI etiology with demographic and injury characteristics, LOS, and functional outcomes were analyzed. For these analyses, etiology was merged into 7 categories: degenerative, benign tumor, malignant tumor, vascular, infection, and inflammation. Three patients in the category "other" were excluded

from these analyses. Nonparametric statistics were used because of the skewed score distribution of LOS and functional outcome at discharge. Chi-square for cross-tabulation data, Kruskal-Wallis test to compare outcome variables between etiology groups, and Wilcoxon test to compare functional status at admission and discharge were used. *P* values of <.05 were considered significant. Data analysis was performed using SPSS 18.0.

## Results

A total of 128 patients were included. Four patients were excluded because of exceptional LOS scores: 3 switched to outpatient rehabilitation within the first days of admission, and 1 continued inpatient rehabilitation for 486 days. Therefore 124 patients remained for statistical analysis.

Demographic and SCI characteristics are displayed in **Table 1**. Patients had a mean age of 54.9 years (SD 13.7; range, 17-82) and stayed a median time of 22.5 days (IQR, 15-41; range, 5-186) in an acute care hospital prior to rehabilitation admission. Most patients were classified as AIS D and had paraplegia, indicating a relatively mild SCI.

Most frequent etiologies were spinal degeneration, tumor compression, vascular disease, infection, and inflammation. Pattern of onset was mostly either acute or chronic. In 14% of patients, rehabilitation was interrupted one or multiple times, mostly by a period of hospital admission. The most common discharge destination was a private residence.

Demographic and NTSCI characteristics are shown in **Table 2**. Etiology was associated with sex, pattern of onset, and completeness of NTSCI, but not with age and level of NTSCI. NTSCI due to degeneration, benign tumor, or infection were mostly AIS D. AIS A lesions were only found in NTSCI due to malignant tumor (21.1%), vascular problems (18.5%), or infection (20%). Acute onset (within 1 day) was only common in NTSCI of vascular origin.

## Length of stay and functional outcome

Median LOS in inpatient rehabilitation was 61.0 days (**Table 3**). LOS was significantly associated

**Table 1.** Participant characteristics

Characteristics	n	%
Sex, male	62	50.0
Age at admission, < 55 years	61	49.2
AIS at admission		
AIS A	11	9.2
AIS B	11	9.2
AIS C	17	14.3
AIS D	80	67.2
Missing	5	
Level of SCI at admission, paraplegia	95	76.6
Pattern of onset		
Acute (1 day)	39	32.5
Subacute (2-6 days)	17	14.2
Progressive (1 week – 1 month)	18	15.0
Chronic (>1 month)	46	38.3
Missing	4	
Etiology		
Degenerative	32	25.8
Tumour – benign	20	16.1
Tumour – malignant	19	15.3
Vascular - haemorrhagic	11	8.9
Vascular – ischaemic	16	12.9
Infection – viral	2	1.6
Infection – bacterial	8	6.5
Infection – tuberculosis	1	0.8
Infection – other	2	1.6
Inflammation – demyelination	2	1.6
Inflammation – other	8	6.5
Other	3	2.4
Interrupted rehabilitation, yes	17	14.0
Discharge destination		
Private residence	104	84.6
Hospital	6	4.9
Rehabilitation hospital	3	2.4
Nursing home	8	6.5
Assisted living	2	1.6
Missing	1	

Note: AIS = American Spinal Injury Association Impairment Scale.

with etiology. LOS after NTSCI due to vascular problems or inflammation was much longer than LOS after other causes of NTSCI in our sample.

Functional status scores at admission and at discharge were also associated with etiology. Patients with degenerative NTSCI showed the highest functional status scores at admission and

**Table 2.** Demographic and NTSCI characteristics by etiology

Characteristics	Degenerative	Tumour –benign	Tumour – malign	Vascular	Infection	Inflammation	P
Sex, % male	56.3	20	57.9	55.6	69.2	30	.034
Age, % <55 years	53.1	40	47.4	55.6	38.5	40	.821
AIS, % A-C	13.8	22.2	52.6	48.1	15.2	50	.010
Level, % paraplegia	68.8	90	78.9	70.4	76.9	80	.589
Onset, %							
1 day	23.3	15.8	26.3	66.7	16.7	30	
2 days to 1 month	26.7	31.6	31.6	25.9	50	20	
>1 month	50	52.9	42.1	7.4	33.3	50	.005

Note: AIS = American Spinal Injury Association Impairment Scale; NTSCI = nontraumatic spinal cord injury.

discharge. Functional status scores at discharge were high in most etiology groups. Patients with NTSCI due to malignant tumor or inflammation showed the worst functional status at discharge.

Only 3 patients (2.4%) showed worsening functional status during inpatient rehabilitation and median overall improvement was 30 points on a 0 to 100 scale. Significant gain in functional status during inpatient rehabilitation was shown in all etiology groups. Gain was not significantly associated with etiology, although there was a wide range of median scores, from 12.5 points after malignant tumor to 47.5 after vascular NTSCI. Four of the 7 etiology groups however showed a more or less similar functional gain in the range of 22.5 to 35 points. The rate of functional improvement was associated with etiology. Patients with NTSCI due to inflammation lagged behind with 0.18 points per day. Most etiology groups however showed a more or less similar rate of improvement in the range of 0.40 to 0.53 points per day.

## Discussion

In a 5-year period, 128 NTSCI patients were admitted to De Hoogstraat for their first inpatient rehabilitation. Most patients were classified as AIS D and paraplegia, indicating relatively mild SCI. The most frequent causes of NTSCI were spinal degeneration, tumor compression, and vascular disease, followed by infection and inflammation. There were significant differences in the LOS

and functional outcome between the different NTSCI etiologies, but there were no significant differences regarding functional improvement during inpatient rehabilitation.

## General characteristics

The large number of included patients confirms that NTSCI is not a rare indication for rehabilitation.<sup>3,8,14</sup> Our earlier nationwide study showed that the majority (54.7%) of new SCI in the Netherlands were of nontraumatic origin.<sup>4</sup> Demographic and injury characters of the patients in this study were comparable with those in other NTSCI studies. Both sexes were equally represented.<sup>2-4,6,8-11,14,19,20</sup> Mean age at admission was 54.9 years, which is also comparable to other studies reporting mean ages between 48 and 62.<sup>2-4,7,10,11,14,15</sup> The 76.6% of patients with paraplegia falls in the range of 60% to 80% of patients with paraplegia or having a conus/cauda lesion in other studies.<sup>2-4,6-8,10,13,14</sup> Similarly, only a minority of patients is reported to have a complete lesion (AIS A).<sup>2-4,6-8,10,11,19,20</sup> Spinal degeneration, tumor compression, and vascular disease were the most frequent etiologies in our study as well as in other studies.<sup>3,4,8-11</sup>

In our study, most patients had an acute or chronic pattern of onset. The only other study investigating pattern of onset reported that 79% of patients had an onset within 1 week compared to 46.7% in our study.<sup>9</sup>

**Table 3.** Rehabilitation outcomes by nontraumatic etiology of SCI

Etiology	N	Mean ± SD	Median	IQR	Statistic <sup>a</sup>	P
<b>Length of rehabilitation hospital stay</b>						
Degenerative	32	60.9 (44.2)	49.5	30.3 – 79	K-W = 22.19	.000
Tumour – benign	20	74.2 (69.6)	50	30.8 – 88.5		
Tumour – malignant	19	61.8 (40.7)	49	33 – 77		
Vascular	27	130.1 (83.9)	112	56 – 177		
Infection	13	83.2 (66.3)	51	36.5 – 144		
Inflammation	10	121.6 (60.8)	115.5	72.3 – 154.5		
Total group	121	86.1 (67.8)	61	38.3 – 111.5		
<b>Functional status at admission (0-100 scale)</b>						
Degenerative	28	67 (23.5)	72.5	42.5 – 88.8	K-W = 16.32	.006
Tumour – benign	20	50 (21.3)	52.5	30 – 68.8		
Tumour – malignant	16	42.2 (18.7)	37.5	26.3 – 62.5		
Vascular	24	46.5 (24.3)	37.5	26.3 – 68.8		
Infection	13	50.8 (21.4)	50	32.5 – 67.5		
Inflammation	10	43.5 (17)	37.5	33.8 – 53.8		
Total group	114	51.9 (23.3)	47.5	30-70		
<b>Functional status at discharge (0-100 scale)</b>						
Degenerative	28	92.2 (15.6)	100	90 – 100	K-W = 25.95	.000
Tumour – benign	19	86.1 (20)	95	90 – 100		
Tumour – malignant	17	65 (25.8)	65	42.5 – 90		
Vascular	25	83 (20.8)	95	77.5 – 97.5		
Infection	13	81.9 (26.7)	95	77.5 – 100		
Inflammation	10	64 (24)	75	37.5 – 85		
Total group	115	81.2 (23.2)	90	75-100		
<b>Gain in functional status during rehabilitation</b>						
Degenerative	28	25 (17.8)	22.5	10 – 40	K-W = 9.10	.105
Tumour – benign	19	35 (20.5)	30	15 – 50		
Tumour – malignant	16	21.6 (22)	12.5	5 – 33.8		
Vascular	24	37.1 (27.1)	47.5	11.3 – 55		
Infection	13	31.1 (20.6)	35	7.5 – 45		
Inflammation	10	20.5 (22.2)	22.5	-1.3 – 40		
Total group	110	29.2 (22.3)	30	10 – 45		
<b>Gain in functional status per day inpatient rehabilitation</b>						
Degenerative	28	.50 (.40)	.45	.22 – .63	K-W = 9.64	.020
Tumour – benign	19	.72 (.64)	.52	.35 – 1.04		
Tumour – malignant	16	.37 (.32)	.34	.12 – .53		
Vascular	24	.38 (.28)	.40	.21 – .49		
Infection	13	.58 (.56)	.53	.14 – .87		
Inflammation	10	.16 (.22)	.18	.00 – .35		
Total group	110	.47 (.44)	.40	.21 – .60		

Note: IQR = interquartile range; SCI = spinal cord injury.

<sup>a</sup> Kruskal-Wallis test excluding the category other (n = 121).

Median LOS in the acute hospital was 22.5 days. The 2 available studies reported a shorter mean acute hospital stay of 11.8 to 14.8 days in different level-category groups<sup>3</sup> and a mean acute hospital stay of 10.4 days.<sup>14</sup>

### Length of stay

Mean LOS in the rehabilitation center was 86.2 days, which is in the middle of the wide range of LOS in patients with NTSCI in the literature

(22 to 155 days).<sup>2-4,6,8,9,15,19</sup> LOS in this study was considerably shorter than the median 155.5 reported in the earlier study,<sup>4</sup> probably reflecting both a higher percentage of patients with AIS D in the current study and a broader trend toward shorter LOS in later years of data collection (2006-2010 instead of 2002-2007).

NTSCI etiology was associated with LOS in our analysis. The shorter LOS of persons with NTSCI due to malignant tumor is likely caused by a different policy toward these patients. Rehabilitation goals are mainly focused on independence and management of bladder and bowels and less on fitness and social reintegration.<sup>21</sup> The longer stay in patients with a vascular cause might be due to more comorbidity and complications (diabetes, other vascular diseases) in this patient group. Only one other study differentiated LOS by NTSCI etiology.<sup>9</sup>

### Functional outcome

Median functional status scores were 47.5 at admission and 90 at discharge. Osterthun et al<sup>4</sup> used the same measure and reported lower mean scores in their NTSCI sample of 32 at admission and 71 at discharge, consistent with a lower proportion of patients with AIS D in their study. Improved functional status during inpatient rehabilitation was also showed by studies using accepted instruments such as the Barthel Index, with mean scores of 31.3 at admission and 55.6 at discharge,<sup>6</sup> and the Functional Independence Measure (FIM).<sup>2,3,8,9,13,15</sup> Ones et al reported in their NTSCI group a mean admission FIM score of 89.7 and a discharge FIM score of 92.8.<sup>2</sup>

### Limitations

This study has several limitations. Because of its retrospective character, some missing values were present, and inaccuracies from incorrect or incomplete documentation in medical files may exist.

A second limitation is the size of the study. Our sample size was not particularly small compared to other NTSCI studies, but the number of patients per etiology group was small,

limiting the statistical power of our analyses and the possibility of performing proper post hoc comparisons. For this reason, our results must be considered exploratory and in need of future confirmation.

Further, it is uncertain whether patients from this center are representative of the greater Dutch NTSCI population. Compared to our earlier nationwide study,<sup>4</sup> the current study included more patients with AIS D lesions (80% vs 47%). This difference might reflect a trend toward treatment of patients with less severe SCI in general, a center-specific result, or underreporting of patients with AIS D in the previous study.<sup>4</sup> However, mean age (57 vs 55 years) and percentage of males (50% vs 55%) were similar in both studies. In both studies, age might be overestimated, because children with NTSCI are generally admitted to pediatric departments, which were not included in these studies.

Future studies utilizing larger patient groups and multivariate analysis to account for differences in, for example, age and gender are needed to identify the contribution of etiology to the efficiency of rehabilitation.

### Conclusion and Recommendation

Degenerative spinal disease, tumor compression, and vascular disease were the most common causes of NTSCI in this study. As the most frequent causes of NTSCI are age-related, it is expected that the incidence of NTSCI will grow with the increasing age of the population. This study extends the finding of our earlier study that patients with NTSCI might benefit as much from inpatient rehabilitation as patients with TSCI. Their LOS is relatively short and their discharge destination was private residence. This benefit was present in all NTSCI etiologies, but due to the small numbers of patients in each etiology group, the outcomes of this study need confirmation in larger, preferably multicenter or even multinational prospective studies.

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